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Epidemiology of musculoskeletal injury in the California film and motion picture industry

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Abstract

Introduction—Musculoskeletal injury exerts a significant burden on US industry. The purpose of this study was to investigate the frequency and characteristics of musculoskeletal injuries in the California (CA) film and motion picture (FMP) industry which may result in unforeseen morbidity and mortality.

Methods—We reviewed the workers' compensation (WC) claims database of the Workers' Compensation Insurance Rating Bureau of California (WCIRB) and employment statistics through the US Bureau of Labor Statistics (BLS). We analyzed the frequency, type, body part affected, and cause of musculoskeletal injuries.

Results—From 2003 to 2009, there were 3505 WC claims of which 94.4% were musculoskeletal. In the CA FMP industry, the most common injuries were strains (38.4%), sprains (12.2%), and fractures (11.7%). The most common sites of isolated injury were the knee (18.9%), lower back (15.0%), and ankle (8.6%). Isolated musculoskeletal spine injuries represented 19.3% of all injuries. The most common causes of injury were work-directed activity (36.0%) and falls (25.5%).

Conclusion—We present the first report on the unique profile of musculoskeletal injury claims in the FMP industry. This data provides direction for improvement of workplace safety.

Keywords

California; film and motion picture industry; musculoskeletal injury; workers' compensation

Introduction

Musculoskeletal injury exerts the greatest burden on US industry. The impact on specific sectors, such as the film and motion picture (FMP) industry, remains unexplored. The currently reported injury statistics are generalized and inconsistent among reporting agencies. As a result, the risk of sustaining musculoskeletal injuries in the FMP industry is undefined (1–4). There are many reasons for the absence of reliable data. Reports detailing WC claims typically do not leave the corporate sector in privately-insured companies, which experts speculate removes up to one-third of California (CA) FMP companies from publicly reported data. Claim reporting for publically-insured FMP companies is only loosely regulated, providing grounds for gross underreporting (5–7).

There is a misperception that FMP employment is benign save for the role of the stunt performers. The Center for Safety in the Arts compiled a list of 40 fatalities in FMP production from 1980 to 1989. Of these, 21 occurred during stunts and special effects. However, only eight fatalities were stuntmen. The others included four cameramen, six actors, one pilot, and two bystanders. The remaining 19 occurred during non-stunt filming and included five helicopter-related fatalities, a crane accident, electrocution, and being hit by a vehicle and steel beam. The CA division of the United States Bureau of Labor and Statistics (US BLS) further documented an increasing frequency of injuries in FMP in CA from 1980 to 1988 and 1.5 fatalities per 1000 injuries, which is over three times greater than the ratio for manufacturing and construction (8, 9).

The Screen Actors Guild published a detailed account of non-fatal injuries in *Variety*. It described 600 injuries in the US FMP industry from 1982 to 1984, only half of which were stunt performers. The report attributed 34% of injuries to fight scenes, 7% to equipment failure, 5% to horses, and 11% to other factors (10). The Workers' Compensation Board of British Columbia (Work Safe BC) is the only other and most comprehensive source to date to analyze WC claim data in Canadian FMP production. Work Safe BC found that from 2006 to 2010, the majority of claims by type, nature, and cause to be due to overexertion (29%), strains (56%), and sustained on working surfaces (20%), respectively (11, 12).

Employers and employees of the FMP industry should be aware of the presence and magnitude of hazards which may result in unforeseen morbidity and mortality. However, the currently available data is too limited to influence policy. Furthermore, no study has looked at regional data, specifically for California, which is arguably the epicenter of the FMP industry. In our study, we present the first epidemiological data on the frequency and characteristics of musculoskeletal injury claims in the CA FMP industry. We predicted that the majority of injuries would be musculoskeletal in nature and that the FMP industry will have a distinct injury profile when compared to CA industry in general.

Materials and methods

We assessed and analyzed the Workers' Compensation (WC) claims database, provided by the Workers' Compensation Insurance Rating Bureau of California (WCIRB). The WCIRB is a private, nonprofit association that collected data from all of the 400 licensed WC

insurance companies in California, based on local and statewide industry employment statistics through the US Bureau of Labor Statistics (BLS).

The WCIRB database was queried to generate two customized data sets of itemized WC claims in CA from 2003 to 2009: WC claims for all industries, and WC claims in FMP. Each claim contained the following: year of injury, part of body injured (e.g. neck – soft tissue injury), nature of injury (e.g. strain), cause of injury (e.g. repetitive motion), total incurred indemnity, and total incurred medical cost. All information was de-identified from both employer and employee. We further sorted the data into musculoskeletal and non-musculoskeletal injuries based on the injury description codes. A detailed list of injury description codes can be found in the “WCIRB Data Reporting Handbook, 2013 – Appendix 5 – Injury Description Codes”, available through WCIRB.

We consolidated the 75 codes used by the WCIRB for cause of injury into 12 categories: exposure, falling, tool or machinery-related, non-tool or machinery-related, vehicular, animal-related, explosions, other workers, criminal, work-directed activity and other (which included rare events such as plane crashes and natural disasters). “Work-directed activity” injuries were defined as “an injury caused by a seemingly benign activity mentioned in a description of work responsibilities and were not otherwise placed in other categories”. Examples of WCIRB codes in this category are “pushing”, “lifting,” “jumping” and “repetitive motion”.

Corresponding yearly local and statewide industry employment statistics were provided by the US BLS for all industries in CA as well as for the FMP industry specifically. The industry codes for the respective FMP production sectors utilized by the WCIRB were consistent with the industry codes used by the US BLS to track employment.

Using SPSS® program (SPSS 20.0 for Windows, SPSS Inc., Chicago, IL, USA), we analyzed the frequency, type, body part affected and cause of musculoskeletal injuries. We compared the data from the CA FMP industry to the injury data available across all CA industries. We propose using the CA across-industry claims as the best available benchmark for the FMP industry claims with the rationale that the across-industry data set is large (more than 625,000 claims) and represents many, varied workplaces in CA. All statistical calculations were performed using the appropriate χ^2 or Student’s t-test method. For the purposes of this study a p-value of <0.05 was considered statistically significant.

Results

Employment

Employment in the CA FMP industry increased by 105% from 2003 to 2009, rising from 50,162 to 102,971 employees (Figure 1). The CA FMP industry employed 88,383 persons on average per year. During 2003–2009, the total employment of CA remained relatively stable compared to the FMP industry, falling by 1.3% from 13 million to 12.8 million employees.

Frequency of injury claims

From 2003 to 2009, there were a total of 3505 WC claims in the CA FMP industry, of which 94.4% (3307 claims) were musculoskeletal. This represents 472 musculoskeletal claims per year. Across CA industries, there were a total of 625,361 WC claims, of which 92.5% (578,724 claims) were musculoskeletal. This represents 82,675 musculoskeletal claims per year. On average, FMP employees had a 17-fold increased risk of sustaining a musculoskeletal injury over a non-musculoskeletal one. In CA across industries, the comparative risk was slightly lower, with an average of a 13-fold increased risk of musculoskeletal over non-musculoskeletal injury.

Risk of injury trend

The risk of sustaining an musculoskeletal injury in the CA FMP industry ranged from 0.42% to 1% each year with an average of 0.54% (Figure 1). Across all CA industries, the risk of sustaining an musculoskeletal injury ranged from 0.52% to 0.85% per year with an average of 0.62%. From 2003 to 2009, both the FMP industry and CA industries showed a marked down trend in risk of injury, with a reduction in risk of injury by 57% and 34%, respectively. Although the FMP industry had a lower risk of injury and greater reduction in risk over time compared to CA industries in general, there was not a significant difference in the risk of musculoskeletal injury by year between the two groups ($p=0.12$) nor in the rate of decline ($p=0.32$).

Type of injury

The five most common types of injury were identical in order between the CA FMP industry and across CA industries (Table 1). In the CA FMP industry, the most common injuries were strains (38.4% or 181 per year), sprains (12.2% or 58 per year), fractures (11.7% or 55 per year), contusions (9.7% or 46 per year) and lacerations (4.0% or 19 per year). Across CA industries, the most common injuries were categorized as strains (34.5% or 28,498 per year), sprains (10.6% or 8781 per year), fractures (8.5% or 7025 per year), contusions (6.9% or 5698 per year) and lacerations (4.8% or 3966 per year). Amputations, concussions, crushes, dislocations, inflammation, punctures, ruptures, severances and carpal tunnel each individually accounted for <4% in the CA FMP industry and across CA industries. For both the across-industry and FMP industry data, a large amount of claims were not classified (22.1% and 15.7%, respectively) or had multiple classifications (3.1% and 1%, respectively). There was a significant difference between the frequencies injury types between the two groups ($p<0.001$).

Extremity injury

In the CA FMP industry, 32.9% of isolated injuries were sustained to the upper extremities (UE), from shoulder to fingers, and 30.0% were sustained to the lower extremities (LE), from hip to toes (Figure 2). Of extremity injuries, 45.7% were to the UE and 54.3% to the LE. Across CA industries, 63.8% of extremity injuries were to the UE and 36.2% to the LE. Additionally, isolated musculoskeletal spine (including para-spinal soft tissue, vertebral, disk, and cord) injuries represented 19.3% and 24.0% of all injuries in the CA FMP industry

and across CA industries, respectively. Frequency of UE, LE and spine injury were significantly different between the CA FMP and CA across-industry claims ($p<0.001$).

Site of injury

The most common anatomic sites for isolated injury in the CA FMP industry were the knee (18.9%), lower back (15.0%), ankle (8.6%) and shoulder (5.5%). The knee was the most common LE injury representing 48.3% of LE injuries and the shoulder the most common UE injury representing 16.5% of UE injuries. The most common locations of injury across CA industries were the lower back (18.5%), knee (11.4%), wrist (8.1%), and shoulder (7.7%). The knee was the most common LE injury representing 48.4% of LE injuries, and the wrist was marginally the most common UE injury with 19.5% of UE injuries. The difference between sites of injury for the two groups was significant ($p<0.001$).

Cause of injury

The six most common causes of injury were identical in order between the CA FMP industry and across CA industries (Table 2). The most common cause of injury in the CA FMP industry were work-directed activity (36.0% or 170 per year), falling (25.5% or 121 per year), non-tool or machinery related (13.8% or 65 per year), tool or machinery related (6.0% or 28 per year) and vehicular (4.2% or 20 per year). Industry-wide, the most common causes injuries were work-directed activity (38.4% or 31,707 per year), falling (22.5% or 18,596 per year), non-tool or machinery related (11.0% or 9067 per year), tool or machinery related (7.4% or 6090 per year) and vehicular (4.4% or 3658 per year). Exposure, animals, explosions, criminal activity, other workers and other causes each individually accounted for <1% in both data sets. In both the CA FMP industry and CA industry-wide data, a large amount of claims did not have a categorized cause (12.2% and 14.0%, respectively). The frequencies of causes of injury between the two data sets was significant ($p<0.001$).

Discussion

We present the first comprehensive report of musculoskeletal injury in the FMP industry. Our analysis draws many potential points of discussion, but we will focus on what we feel are the most important aspects: [1] the need for musculoskeletal specialist to study WC claims in the FMP industry; to help in providing a safe environment for these individuals through injury prevention programs in FMP industry; [2] the unique injury profile in the FMP industry; and [3] the seemingly lower risk of injury in FMP compared to CA industries in general.

As we predicted, musculoskeletal injuries constituted the majority of WC claims, representing almost 95% of claims in both the CA FMP industry and across CA industries from 2003 to 2009. The preponderance of strains, sprains, and fractures, which constituted over 60% of the injuries, highlights the need for involvement of orthopedic surgeons and specialists in this multi-billion dollar industry. We found that the most common types of musculoskeletal injury – strains, sprains, and fractures – in the CA FMP industry were consistent with the insurance claims across CA industries. Work Safe BC also found that strains constituted 56% of all claims from 2006 to 2010, which is consistent with our data

(11, 12). The majority of these injuries will be referred to orthopaedists at some point for evaluation and management. Therefore, the FMP industry represents a major contributor to the potential patient base. The onus lies on the orthopaedists to seek out this underrepresented population.

As our second point, the CA FMP industry displayed a unique injury profile in many regards. The frequencies of UE and LE injuries were opposite those of CA industries in general. The CA FMP industry had a significantly greater frequency of LE injuries, presumably due to the significantly greater frequency of fall claims. This may be due to the nature of industry, with many employees working at heights, in dimly-lit sets, and distracted by what is being filmed. Moreover, FMP employees, particularly those involved with set design, are constantly working in new and changing environments, decreasing their familiarity with their surroundings and increasing chances of falls. The increased number of falls in the FMP industry may be a reason that fractures are more common injuries than in CA industries in general (13, 14).

The CA FMP industry also had a unique profile for isolated anatomic sites of injury. The two most common anatomic sites – lower back and knee – were consistent but reversed. Additionally, ankle injuries were twice as common, but wrist injuries only half as common when compared to CA industries in general. Corroborating our findings of WC claims across CA industries, Mroz et al. found that lower back, knee, and hand injuries, in that order, were the three most common WC claims (15). Work Safe BC also found lower back injury to be the most common injury and knee injury to be the fourth most common cause of claims filed (11). This highlights the unique profile of the CA FMP industry: increased numbers of knee and ankle injuries with fewer wrist injuries. Furthermore, this unique injury profile in the FMP industry suggests that general industry injury data does not translate to subsectors and that we must take a closer look at each industry to fully understand the associated risk.

The CA FMP industry was additionally found to have a unique cause of injury profile when compared to CA industries in general. As aforementioned, the CA FMP industry had more injuries caused by falls. This is consistent with both the SAG 1984 report of 600 injuries in FMP production in which they attributed approximately one-third of injuries to falls, as well as the Work Safe BC data from 2006 to 2010 in which 27% of claims were directly fall-related. The SAG and Work Safe BC data however was measured out of all injuries and not only those of musculoskeletal nature (10, 11).

Additionally, the CA FMP had fewer injuries caused by work-directed activity, possibly due to the FMP industry being less physically demanding or requiring less repetitive motion. Interestingly, the explosion-related injuries that may be thought to be a stereotype of Hollywood stunts (16) were indeed five times more common in the FMP industry than across CA industries. One notable finding was that vehicular injury, which was cited as contributing to 15% of injuries in a 1985 report by Robb, now represents only 4% of WC claims. Due to the paucity of data reported in the 1980s, we can only speculate that either vehicular safety has improved or other causes of injury have increased alternatively, “journey” claims to and from work were likely excluded from eligibility from the workers compensation system, as they were in many jurisdictions in the 1990s and 2000s (17).

To address our third point, the CA FMP industry had an overall 13% lower relative risk of musculoskeletal injury compared to CA industries in general. It is unlikely this is due to a baseline safer work environment because, in 2003, the relative risk of musculoskeletal injury in the CA FMP industry was actually 18% higher than CA industries in general. More likely, the lower frequency of musculoskeletal injury claims reflects the rapid increase in CA FMP employment without an increase in reported injuries. Between 2003 and 2009, employment in the CA FMP industry more than doubled without an increase in WC claims. This translated into a dramatic decrease in the frequency of injury claims in the CA FMP industry from 1.00% in 2003 to 0.43% in 2009. CA industries mirrored this trend to a lesser degree, from 0.85% in 2003 to 0.56% in 2009. One plausible explanation is that workers (particularly in FMP) hired in 2004 and afterwards were more likely to utilize private insurance, which would not have publically available injury data and, thus, not be included in this analysis (18, 19).

As our fourth and final point, our findings call attention to routine activities being the major cause of injuries, even in the fast-paced and glamorous FMP industry. Together, work-directed activity and falls accounted for more than 60% of all injuries in both the FMP industry and across CA industries. These injuries are preventable (20) but still cause the bulk of musculoskeletal injuries, underlining the importance of implementing preventative measures for outwardly benign activities (21, 22). These causes of injury are both common and preventable, making them a perfect target for programs addressing workplace safety and practices. Research is available to help employers implement these programs. For example, Bigos and Tveito conducted systematic reviews on prevention of lower back injury in the workplace and both found directed exercise to be a valid measure for reducing lower back injury (23, 24).

There is presently no database that universally collects and records WC claims. Of those available, the largest and by far most comprehensive is the WCRIB (25). Due to the paucity of data sources, it is not a surprise that there is no scientific literature on the topic of musculoskeletal FMP injuries and reports are subjective, case-based, and unreliable. We present the first concrete data analysis of this detail and magnitude of an otherwise highly-privatized industry. Data of this nature is important to the FMP industry employers, employees, and medical community alike. FMP companies can improve workplace safety based the data presented here on the frequency, types and causes of injuries. Specifically, the preponderance of sprains and strains in the lower back, knee, ankle and shoulder can serve to direct these efforts. The knowledge that employees are primarily being injured while performing work-directed or falling, can further focus efforts on preventative measures and rapid identification of injuries. Employees, on the other hand, currently enter an industry of undetermined workplace safety (26, 27). They should be aware of what types of risks are most and what causes to avoid. Finally, medical professionals, specifically orthopedic surgeons, would benefit from knowing their patient base.

Conclusion

We present the first report on frequency and injury characteristics of musculoskeletal injury claims in the FMP industry. The frequency and relative risk of musculoskeletal injury versus

non-musculoskeletal injury claims were high. The FMP employer, employee, and medical community alike can therefore serve to benefit from this data. With this data, we direct the FMP industry toward areas of improvement, namely in regard to falls and work-directed activity. The employee can also for the first time be aware of the true level of risk involved in a seemingly benign field. Finally, we highlight the need for orthopaedists in this patient base. Many unanswered questions still remain, least of which is not the financial impact of these injuries.

Limitation

Our study had some unavoidable limitations. Due to a large privately insured sector of the CA FMP industry, we are looking at only a portion of the total number of injuries. Furthermore, after 2004, FMP workers were more likely to utilize private insurance. However, we do not believe that this introduces significant sample bias as the injuries sustained should be similar regardless of whether an employee utilizes an insurance company with public or private status. Also, because the data was de-identified and contained no demographic information, we could not explore the likelihood of sustaining certain injuries based on employee or employer characteristics. We could also not compare injury amongst specific FMP companies nor gender nor job title. Finally, since this is the first report of this nature to utilize the WCIRB, the internal validity has yet to be explored. There are potentially substantial issues with collection and quality assurance of these data systems, additionally making inter- and intra-observer reliability difficult to gauge.

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Figure 1.

Yearly employment and risk of injury trends, 2003–2009. California (CA) employment across all industries remained relatively stable from 2003 to 2009 while CA film and motion picture (FMP) employment increased dramatically, more than doubling from 2003 to 2009). Risk of injury in CA FMP decreased from 2003 to less than one-half that rate in 2009.

Figure 2.

Injuries by body part in the California film and motion picture industry, 2003–2009. Lower extremity injuries were most common, followed by upper extremity, and then trunk injuries (excluding multiple injuries which constituted roughly one-quarter of all injuries).

Table 1

Musculoskeletal related injury by type, 2003–2009.

Type of injury	CA FMP		CA all industries	
	Number of claims per year	% of total claims	Number of claims per year	% of total claims
Amputation	2	0.42	613	0.74
Concussion	3	0.63	273	0.33
Contusion	46	9.70	5698	6.89
Crushing	6	1.27	873	1.06
Dislocation	9	1.90	1157	1.40
Fracture	55	11.60	7025	8.50
Inflammation	8	1.69	2373	2.87
Laceration	19	4.01	3966	4.80
Puncture	4	0.84	574	0.69
Rupture	3	0.63	333	0.40
Severance	1	0.21	119	0.14
Sprain	58	12.24	8781	10.62
Strain	181	38.19	28,498	34.47
Carpal tunnel	0	0.00	1543	1.87
Multiple	5	1.05	2590	3.13
Not otherwise classified	74	15.61	18,259	22.09
Total	474	100	82,675	100

Table 2

Musculoskeletal related injury by cause, 2003–2009.

Cause of injury	CA FMP		CA all industries	
	Number of claims per year	% of total claims	Number of claims per year	% of total claims
Exposure	5	1.06	356	0.43
Falling	121	25.58	18,596	22.49
Tools/machinery	28	5.92	6090	7.37
Non-TM	65	13.74	9067	10.97
Vehicular	20	4.23	3658	4.42
Directed	170	35.94	31,707	38.35
Animals	1	0.21	368	0.45
Explosions	1	0.21	25	0.03
Other workers	4	0.85	825	1.00
Criminal	0	0.00	360	0.44
Other	0	0.00	62	0.07
Not otherwise classified	58	12.26	11,557	13.98
Total	473	100	82,673	100